Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Dworshak Dam Impacts Assessment and Fisheries Investigation

Bonneville project number, if an ongoing project 8709900

Business name of agency, institution or organization requesting funding
Idaho Department of Fish and Game

Business acronym (if appropriate) IDFG

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
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NPPC Program Measure Number(s) which this project addresses.
10.3C.1, 10.3C.2, 10.3C.3

NMFS Biological Opinion Number(s) which this project addresses.

N.A.

Other planning document references.

N.A.

Subbasin.

Lower Snake River Subbasin

Short description.

Determines ways to minimize entrainment losses of fish into Dworshak Dam. Devices such as strobe lights, sound, and selective water withdrawal are being tested. Also, impacts to resident fish causes by drawdowns and routine operations are evaluated.

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
	Anadromous fish		Construction		Watershed
x	Resident fish		O & M		Biodiversity/genetics
	Wildlife		Production	x	Population dynamics
	Oceans/estuaries	x	Research	+	Ecosystems
	Climate	+	Monitoring/eval.		Flow/survival
	Other		Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat en-enhancement/restoration
			Acquisitions		

Other keywords.

entrainment losses, turbine mortality,

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
NA		

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1.	Increase the kokanee population to 30 to 50 adults/ha by reducing entrainment losses through the use of strobe lights.	a.	Install strobe lights in the forebay of Dworshak Dam near the reservoir outlets.
		b.	Operate lights throughout the winter and spring.

		c.	Measure kokanee densities in the forebay, and in the strobe lighted area.
		d.	Monitor entrainment of kokanee using hydroacoustics .
		e.	Estimate the kokanee population in the reservoir and calculate the annual survival rate to determine the population effect of entrainment losses.
2.	Determine the effect of reservoir drawdowns for anadromous fish flows and flood control on the kokanee population.	a.	Monitor kokanee population by trawling, hydroacoustics and spawner counts, and relate to changes in dam operation.
3.	Improve sportfishing on the reservoir to 150,000 angler hours by enhancing reservoir fish habitat through the development of rule curves.	a.	Monitor kokanee population by trawling, hydroacoustics and spawner counts, and relate to changes in dam operation.
		b.	Provide biological information to Nez Perce Tribe for use in their modeling work.

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1.	01/1997	12/2003	80%
2.	01/1995	12/2000	10%
3.	01/1991	12/2003	10%

Schedule constraints.

Funding is the biggest constraint since purchasing strobe lights will be a large capitol outlay expense. Another constraint is that the deployment of the lights will be done by the Army Corps of Engineers on a subcontract with us. A list of our milestones includes: purchasing the strobe light equipment, designing the floats and anchor setup to hold the lights, installing the lights near the reservoir outlets, and evaluating their effectiveness.

Completion date.
2003

Section 5. Budget

FY99 budget by line item

Item	**Note**	**FY99**
Personnel		70,000
Fringe benefits		25,000
Supplies, materials, non-expendable property		10,000
Operations & maintenance		14,000
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	The bulk of this money will be for the purchase of strobe lights, power converters, and wiring for their deployment.	360,000
PIT tags	# of tags: 0	0
Travel		2,000
Indirect costs	22% of personnel and operating cost	65,000
Subcontracts	Subcontract with US Army Corps of Eng. for the design and start of construction of a floating structure to hold the strobe lights.	105,000
Other		
TOTAL		651,000

Outyear costs

Outyear costs	**FY2000**	**FY01**	**FY02**	**FY03**
Total budget	467,600	460,000	200,000	200,000
O&M as % of total	5%	10%	20%	20%

Section 6. Abstract

Dworshak Reservoir was built in 1973 by the Army Corps of Engineers. This 718' high dam completely blocked the North Fork of the Clearwater River for anadromous fish and greatly changed the composition of the resident fishery. Our project goal is to improve the resident sport fisheries in the reservoir. Our objective is to minimize entrainment losses of fish into the turbine intakes and reservoir outlets so that a density of 30 to 50 adult kokanee/ ha can be maintained on an annual basis. Reducing entrainment losses of kokanee will also benefit other species by: lessening entrainment of cutthroat, bull trout, and rainbow trout, providing more prey (small kokanee) for bull trout, and allow nutrients (in the form of kokanee spawners) to move upstream into the tributaries. We also propose to monitor the kokanee population annually and relate changes to the operation of the dam. This empirical information can then be used to assist in the development of rule curves for the reservoir.

Our methods are to test behavioral avoidance devices to see if kokanee, and other fish, can be scared away from the intakes to the dam. Strobe light testing began in 1997. Kokanee avoided the strobe lights for the entire night and remained 100 to 130 feet away from them in an open lake environment. The next phase (1999) is to test the lights on-site. Lights will be installed in front of the three turbine intakes on the dam. Density of fish will be measured near the lights, in the forebay of the reservoir, and throughout the entire reservoir to determine population effects of entrainment losses. Fish densities will be determined using mobile, split-beam hydroacoustics. Fixed location hydroacoustics will be used to determine fish losses into the turbine intakes. Hydroacoustic have been used by project personnel since 1993 to monitor the fish population and have been proven to be highly precise.

Section 7. Project description

a. Technical and/or scientific background.

Dworshak Dam blocked the access to hundreds of miles of tributaries for anadromous fish spawning as well as flooded 54 miles of river habitat. The resident fisheries which developed in the reservoir were proposed to mitigate for some of these losses. Thus, our project to improve reservoir fisheries serves to mitigate losses “in place≅ but “out-of-kind≅.

Although twenty one species of fish are found in the reservoir, only three species provide important fisheries (Maiolie, et al. 1992). Of these species, kokanee have become the most dominant and have provided approximately 80% of the total catch (Maiolie et al. 1992). Unfortunately, losses of fish into the turbines and reservoir outlets (entrainment) has caused kokanee populations to vary widely. These entrainment losses were shown to be the main factor limiting kokanee populations in the reservoir (Maiolie and Elam 1994). In 1996, kokanee entrainment exceeded 95% of the all of the kokanee in the reservoir (Maiolie and Elam 1996). In 1997, no age 1 or older kokanee were found in the reservoir during annual trawl sampling and counts of spawning kokanee in index streams dropped from 30,000 to 144 (Maiolie et al. 1997). Thus, controlling entrainment losses is a critical problem and it is the focus of this project.

The problem of entrainment losses is a critical concern throughout the Columbia Basin. Even more specifically, entrainment losses of kokanee has been major problem in Libby Reservoir (Skarr et al. 1996) and Lake Roosevelt . If these losses could be minimized by a means such as strobe lights, then the operation of dams for flood control, power production, providing anadromous fish flows, etc. could be done with less of an impact on resident species. Thus, this project could help to increase the flexibility of dam operations, or to allow a better integration of resident and anadromous fish needs.

Strobe lights have achieve good success at moving fish in a number of different locations. Patrick (1982) found strobe lights worked well with alewife in moving them away from a light source. Patrick (1980) found that American eels strongly avoided strobe lights with no behavioral adaptation over a 48 hour period. Nemeth and Anderson (1992) found that juvenile coho and chinook salmon avoided strobe light. At the York Haven Hydroelectric Project on the Susquehanna River, American shad were “strongly and consistently≅ repelled from the turbine intakes (Winchell et al. 1994). Ploskey and Johnson (1997) found that strobe lights elicited consistent displacement of juvenile salmonids both vertically and horizontally. Field experiments at the Seton Hydro-Electric station in British Columbia tested the response of sockeye smolts to strobe lights at a current velocity approaching 1 m/sec. Strobe lights were found to be 56% effective at guiding downstream migrating fish (McKinley and Patrick 1986). Numerous other studies also exist.

Testing strobe lights began in 1997 and is continuing in 1998. Results are very encouraging. Flash rates of 300 to 450 flashes/minute were highly successful at repelling kokanee in excess of 100 feet (Maiolie et al. 1998, in press). Kokanee also did not become accustom to the lights, and move closer to them, even after a whole night of operating the lights in the same location (Maiolie et al. 1998, in press). We also tested the lights over shallow water (75' deep) and deep water (1000' deep). Strobe lights worked equally well in both situations. Testing in 1999 needs to be conducted on Dworshak Dam to determine how kokanee react to the light under actual field conditions. This will allow us to test the effects of strobe lights on fish that are in a slow current of water and are schooled near the dam for a period of several months.

b. Proposal objectives.

Objective 1. Maintain a kokanee population of 30 to 50 adult kokanee/ha on an annual basis by reducing entrainment losses of fish.

Hypothesis: Entrainment losses can be reduced by using strobe lights to repel fish away from the front of the dam.

Assumptions: That kokanee repelled away from the dam during winter and spring will move throughout the reservoir during other times of the year and live to adulthood.

Objective 2. Determine the effect of reservoir drawdowns for anadromous fish flows and flood control on the kokanee population.

Hypothesis: Reservoir drawdowns for anadromous fish in the fall do not entrain more than 10% of the kokanee in any one year, and winter drawdowns for flood control do not entrain more than 50% of the kokanee population.

Assumption: Massive, quick declines in the total kokanee population are due to entrainment losses and not another mortality factor.

Products: The main product will be the knowledge of how to avoid large-scale losses through Dworshak Dam, and possibly other dams as well. We will also learn the conditions which cause high entrainment losses. These findings will be written in annual reports and a final project completion report. Lastly, the project will purchase strobe light equipment which could be used on Dworshak Dam if the decision is made to outfit the entire dam with strobe lights.

Objective 3. Improve sportfishing on the reservoir to 150,000 angler hours by enhancing reservoir fish habitat through the development of rule curves.

Hypothesis: With proper water level management, the reservoir could once again support a fishery of 150,000 angler hours annually.

Assumption: The biggest assumption is that rule curves will be used once they are developed.

Products: The effects of drawdowns at different times of the year will be determined and this information will be reported to the Nez Perce Tribe for use in their development of rule curves.

c. Rationale and significance to Regional Programs.

How this project relates to the goals of the FWP can best be stated by comparing it to the criteria used by the CBFWA. The project does address specific Council Program measures specified in 10.3C. It is also consistent with management objectives of the State and Tribe. These objectives are spelled out in Idaho Fish and Game's 5 year management plan for Idaho. It also conforms to Council prioritization process according to program measure 10.1B. This measure gives a high priority to "resident fish substitution measures in areas that previously had salmon and steelhead, but where anadromous fish are now irrevocably blocked by federally operated hydropower development≅; this is the case with Dworshak Reservoir. This project work provides a direct benefit to anadromous fish. The reservoir is lowered about 80 feet each summer to provide flows in the lower Snake and Columbia Rivers. By avoiding entrainment losses of fish, the continuation of these flows would be much more palatable to the public, and could be done with little impact to resident fish. Biological objectives of the Dworshak Research project have been developed (see section 4), but they have not be adopted into the Councils Program at this time. Data on entrainment losses, and methods to avoid them, will be used in the development of biological/integrated rule curves for this (and possibly other) storage reservoirs. Being able to avoid entrainment will make the biological rule curves for fish much more flexible. We are not, however, doing the actual development of the rule curves, that task was given to the Nez Perce Tribe. Our findings will hopefully benefit several species of fish within the reservoir. Kokanee are the primary species which will benefit. They are the largest resident fishery in the Clearwater drainage with up to 140,000 hours of fishing effort. But the project also provides direct benefit to non-target species. Avoiding entrainment losses of kokanee should also minimize the losses of cutthroat, rainbow trout or bull trout. An improved kokanee population provides forage for the reservoir's bull trout and smallmouth bass. Also, having 300,000+ kokanee run up tributary streams and die each fall could add significant nutrients to these stream systems.

Rational for the project: Entrainment losses of resident fish are a major concern in the Columbia Drainage. Entrainment losses of kokanee have been shown to be the main factor causing wide fluctuations in the abundance of kokanee in Dworshak Reservoir (from less than 2 adults/ha to 100 adults/ha). Strobe lights have shown positive benefits for other species such as Atlantic salmon, coho, chinook, and American eels (Patrick 1982, Nemeth and Anderson 1992 Winchell et al. 1994, Ploskey and Johnson 1997) . Strobe lights were found to repel kokanee to a distance of 100 feet or more, with no habituation in our own studies. On site testing of strobe lights on Dworshak Dam is the logical next step in solving the problem of entrainment losses.

How this project furthers the goals of the FWP: One goal of the FWP was to "address the loss of salmon and steelhead in those areas permanently blocked to anadromous fish as a result of the constriction and operation of hydroelectric dams≅.

This project falls into this category. The native river habitat has changed into a fluctuating reservoir. This project attempts to improve sport fisheries on the native and introduced fish within this new habitat. It is also a principle of the FWP to "Protect, mitigate and enhance resident fish in hydropower system storage projects to the fullest extent practicle from negative impacts associated with water releases≅. Our work on avoiding entrainment losses clearly does this.

d. Project history

Project number has not changed. Adaptive management implications: Our testing of strobe lights in 1997 was very successful. The next step is put this technology to use on the dam and learn how well it works on-site. This adaptive process would be far more successful and quicker than trying to learn all the answers by off site experiments and then decide how to install lights on the dam.

Project reports and technical papers: see full citations in section G for Maiolie 1988, Mauser 1988, Mauser et al. 1989, Mauser et al 1990, Maiolie et al. 1992, Maiolie and Elam 1993, Maiolie and Elam 1995, Maiolie and Elam 1996, Maiolie and Elam 1997.

Major results achieved: Early worked showed that Dworshak Reservoir was capable of supporting a harvest of over 200,000 kokanee/yr, and also support fisheries for rainbow trout and smallmouth bass. Studies in the late 1980's to early 1990's showed that entrainment was controlling the kokanee population. Hydroacoustic studies in 1994 and 1995 tracked the movements of kokanee up and down the reservoir. They showed that kokanee congregated near the dam during winter and were much more vulnerable to entrainment in late winter and early spring. They also showed that kokanee were least susceptible to entrainment during the early fall when water releases for anadromous fish often take place. Research work in 1994-96 utilized the selector gates on the dam to try to avoid fish losses. Three record year classes were achieved, but in 1996 massive entrainment losses occurred when large amounts of water were released during late winter. Selective water withdrawal was impossible because the selector gates need to be raised when the reservoir elevation is low. Studies in 1997 showed that kokanee are strongly repelled by strobe lights at a flash rate of 250 to 450 flashes per minute and that no habituation to the lights occurred after an entire night of operation.

Past costs: 1988- $111,000 , 1989- $129,000, 1990- $153,000 , 1991- $137,000, 1992- $124,000, 1993- $145,000, 1994- $141,000, 1995- $133,000 , 1996- $169,000, 1997- $167,000 ,1998- $180,000.

e. Methods.

The first objective is to increase kokanee density in the reservoir by reducing entrainment losses. We propose to test strobe lights for their ability to move fish away from the intakes to the dam. Information collected in 1997 (Maiolie et al. 1998, in press) has shown that the lights need to be spaced at no more than 200' intervals across the face of the dam and at a distance of 100' out into the reservoir from the dam. Lights will also need to be spaced at 30' intervals down into the water to a depth of 100'. The strobe lights used in the fish avoidance experiments are made by Flash Technologies. Lights will be computer controlled for different flash rates and to synchronize various lights into a pattern. Split-beam hydroacoustics will be used to determine the density of fish in the forebay and in area lighted by the strobe lights. Stationary hydroacoustics will monitor the entrainment of kokanee into the turbine intakes.

Experimental testing of the strobe lights will be to monitor fish entrainment when the lights are flashing (test unit) versus when the lights are turned off (control unit). Sampling will be stratified by time of day and season of the year. A Student's T test will be used to compare entrainment rates between the control and test units.

Our second objective is to monitor kokanee abundance in the reservoir and relate abundance and survival rates to the operation of the dam that year. This will enable us to determine the effects of low or high water years, changes in dam operation, and drawdowns for anadromous fish flows. It will also tell us the "population effects≅ of operating the strobe lights on the dam.

Kokanee in the reservoir are monitored using three different methods: trawling, spawner counts, and hydroacoustics. These methods are described in Maiolie and Elam 1994, 1995. Trawling is conducted using a 28' diesel powered boat. It pulls a mid-water trawl net that is 10' x 10' at the mouth. The net is towed at a relative fast speed of 1.5 m/sec. Fifteen trawl hauls are made in the reservoir in a stratified random approach (Scheaffer et al. 1990). The sample size of 15 trawls is justified since this level of sampling was shown in the past to produce confidence limits of +/- 25%.

Spawner counts are made by walking up four tributary streams to Dworshak Reservoir on September 25 of each year (+ or - 2 days). These streams are walked from their mouth up to the end of the kokanee run. They have been conducted each year since 1983 and correlate well to our trawl estimates of the adult kokanee population. Thus, they serve as a check for our other population indices.

Kokanee estimates based on hydroacoustics are made using a Simrad split-beam echosounder. We use a stratified uniform sampling design where the reservoir is divided into three sections and transects across the reservoir are run at 2 mile intervals (Scheaffer et al. 1990). Data is analyzed using EP-500 software to provide fish density estimates. This approach has been shown to produce population estimates of kokanee that are within +/- 20% (90% confidence interval).

f. Facilities and equipment.

Currently on the project we have the most expensive pieces of kokanee monitoring equipment such as the trawler, split beam echosounder, and survey boat. We also have a crew that is trained to use these items. We have three vehicles and four computers and more trucks, computers, and equipment is available within the Department should we need to borrow it. We also have 4 strobe lights and 4 power converters for these lights. However, the biggest capitol expense in 1999 will be to buy 60 additional strobe lights. We are currently renting a field office for our crew of large lakes researchers. Rent for this facility is shared with another BPA funded project on Lake Pend Oreille.

There is a considerable amount of other equipment within the Department of Fish and Game which is available to our project if it is needed. The Department also can provide volunteer workers, administrative and computer help, manpower, equipment and storage space, bunk facilities at the Clearwater fish hatchery, and expertise on many subjects.

g. References.

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Section 8. Relationships to other projects

This project complements the work being done by the Nez Perce Tribe. They have another project which is carrying out modelling work to develop rule curves for the reservoir. Our projects have a similar goal of improving the reservoir, but they each operate independently. We also require the assisance of the Army Corps of Engineers. They have indicated a desire to work with us on installing the needed strobe lights.

Section 9. Key personnel

The principal investigator on the project is Dr. Melo A. Maiolie, Principal Fishery Research Biologist. He has been working for the Department of Fish and Game for 11 years, with 8 of those years in fisheries research. His recieved a B.S., M.S. and Ph.D. in Fisheries and Wildlife management from West Virginia State University (1973), and Colorado State University (1977,1985). Please see section G for a list of publications.

Dr. Maiolie works half time on this project and half time on the Lake Pend Oreille Fishery Recovery Project. He has been working on reservoir projects, and projects involving the federal hydropower system since 1977. His Ph.D. work was on the impacts of a pumped-storage power plant on the fish community of a high mountain lake in Colorado.

Section 10. Information/technology transfer

The findings of this project will be distributed several ways. First, quarterly reports on our findings are mailed to interested parties and placed on the Department's internet home page for immediate access. Next, annual reports are written and are available from the BPA library. We also present the findings of our project at review meetings held by BPA, when they occur. Presentations on our research work are also given at meetings of the Idaho Chapter of the American Fisheries Society about every other year. Recommendations from our project are discussed directly with the Regional Fishery Managers in the State to determine whether regulation changes or changes in management direction are needed. Lastly, we present an update of our work annually at the International Kokanee Workshop.